APPENDIX D

Watershed Restoration Program

Watershed Assessment
of
Antelope Valley
And
Bear Valley Unnamed Tributary

Conducted by

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and
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Introduction

An assessment of the hydrologic and erosional conditions of both the Antelope Valley watershed and the adjacent unnamed tributary of the Bear Valley watershed were assessed during the 2007 summer season (Appendix A: Maps). The Antelope Valley Road is a major impact feature that courses through both watersheds. Also assessed was the meadow system of Bear Valley Creek west of the Sierra Brooks Subdivision and a small riparian system near Badenough Creek.

The two primary impacts to watersheds in the Feather River Basin, degraded stream channels and road/stream interactions were the focus of this assessment. These watershed impacts manifest themselves as changes in watershed hydrology and stream channel hydraulics (stream flows, channel connectivity and dimensions) and channel stability (active erosion and sedimentation). Problem areas were documented and ranked in order of stream impacts and restoration needs. Changes to natural stream and riparian morphometry and morphology (stream channel width, depth, slope, pattern, position on the landscape) and the erosion/sedimentation impacts of these features were evaluated. Causal agents were also identified and evaluated to determine their status and potential remedies.

Antelope Valley Watershed

Background and General Condition

The watersheds of Antelope Valley and Bear Valley are located along the southern extent of Sierra Valley and east of the Sierra Nevada mountain range. The streams draining these watersheds flow north into a system of natural and man-made channels within Sierra Valley and eventually drain into the Middle Fork Feather River. Both Antelope Valley and Bear Valley follow northwest trending geologic fractures, or faults.

The predominant rock type making up both watersheds is Tertiary volcanic andesite with intrusions of basalt. The valley bottoms are filled with Quaternary alluvium overlying lake deposits at their downstream ends.

In the Antelope Valley watershed, soil erosion and sedimentation plays a minor role in shaping the watershed. The dominant erosion and transport process is landslide/debris flow, defined as a moving mass of rock fragments, soil, and mud. The material generated by this process covers most of the lower slope areas in the watershed, creating moderately steep fans of fine to coarse material. These fans also cover portions of the valley bottom alluvium and are so numerous that they form a complex of fans that are practically indistinguishable from one another. Besides being the main source of sediment, they are a primary groundwater recharge zone for Antelope Valley and Sierra Valley.

The stream channels of Antelope Valley are mostly degraded, incised into their original geomorphic features, due to historic and ongoing land use impacts. These impacts include over-grazing and trampling by livestock, logging during different land-use eras, road construction and maintenance, and water diversion and impoundments. Naturally occurring impacts, possibly exacerbated by human impacts, include wildfires, winter and spring floods, floods from summer thunderstorms, and mudflows. The most obvious and direct evidence of watershed change is degradation of stream channels and development of entrenchments (aka gullies) that contain most or all streamflows. Relocation and channelization of streams during the early logging era, construction and relocation of the Antelope Valley Road and construction of Palen Reservoir and the system of diversion ditches (Appendix A: Maps) are the primary cause and effect relationships. Stream channels are still actively down cutting within the entrenchments causing further widening (bank erosion) to take place. The result is continued loss of meadow lands and other landscape features (Appendix B: Photos 1 & 2) plus more rapid draining and loss of groundwater.

The operation of a lumber mill near the center of the watershed in the early 1900s, a roadway located along the main stream channel system, used to transport rough-cut material to a finishing mill near Loyalton, and all roads and skid trails used to transport logs from upper watershed areas to the Antelope Valley Mill have directly and indirectly impacted the watershed. Stream channel morphology and condition were directly impacted and changed during mill operation and its impacts continue today. Besides directly diverting and concentrating streamflows, the road system indirectly changed the hydrologic and general condition of the watershed through changes in the streamflow regime and the production of sediment.

The mill was constructed on the floodplain of Antelope Creek and an unnamed tributary, redirecting and channeling streamflows within the site. The main road, constructed to accommodate a steam tractor used to haul the rough-cut lumber was located down the middle of the main stream system, directly diverting and channeling Antelope Creek. The stream channel incised within its meadow floodplain as a result of these impacts and has resulted in the development of a system of entrenchments that contain stream channels at a lowered (inset) elevation (Appendix C: Diagram 1).

The entire meadow/floodplain system in the lower two thirds of the watershed continues to degrade due to the ongoing impacts from the system of active and abandoned roads. Roads and skid trails constructed to haul trees from upper watershed areas to the mill crossed and/or followed the main Antelope Creek channel and its tributaries with no regard to their water flow conditions. Streams have been diverted from their natural channels and confined to ditches. They no longer utilize their natural floodplains. New drainage channels were established that rapidly downcut and eroded into their new locations. Ditches were also constructed to manipulate the flow from Antelope Creek for pasture irrigation and the milling operation. Both soil erosion and stream channel degradation were accelerated.

The cumulative effect of degraded stream channels and of the changes to watershed hydrology has been a decrease in the time water stays in the watershed during the wet season and an increase in the frequency of floods. Because of this decrease in wet season water retention, less water is absorbed into soils, rock and meadows, decreasing the amount of water available for release during the dry season.

Antelope Valley Road. This road is having a major impact on the hydrology and morphometry (width, depth, slope, and pattern) of Antelope Valley Creek. It is interrupting and redirecting the natural flow path and flood flow requirements of Antelope Creek and its tributaries. Up valley of Highway 49, the first 1.5 miles of roadway is entrenched into the landscape, intercepts overland flows and redirects that flow to an inside ditch, discharging what was naturally dispersed flows into a few cross-drains of concentrated streamflow. Concentrating streamflows increases the erosion of the affected slopes and discharges sediment directly into Antelope Creek. Concentrating streamflows also means that water leaves the watershed sooner, flood peaks are increased, dry-season streamflows are reduced and the slope below the road dries sooner.

In the upper portions of the watershed, the Antelope Valley Road often interrupts and captures and/or re-directs streamflows from the natural drainage network. Again, slope and channel erosion is increased and down slope areas are de-watered.

Palen Reservoir and Diversion Ditches. Palen Dam (Appendix B: Photo 3) was constructed in 1952 to impound water for irrigation downstream on land owned by Mr. Palen and now owned by the Balderston Family. Material to construct the dam was excavated from the stream channel and floodplain area upstream of the reservoir. Removal of the material has totally disrupted the natural drainage pattern, function and morphometry of the stream channel and has lowered the base elevation of the entire up-valley stream system, inducing further channel degradation in an already degraded system. Extensive and ongoing erosion is evident throughout the affected area.

A bypass ditch was constructed to divert streamflows around the reservoir to provide irrigation water to downstream water users as provided by the 1940 Upper Middle Fork Feather River Water Rights Decree. Before the dam and diversion ditches, water flowed in three natural drainage channels below the existing dam site. Two ditches were constructed in conjunction with the dam in an attempt to reduce flooding during the wet season and to provide irrigation water during the dry season. The natural drainage channels now only carry water during large flood events.

The natural stream channels and meadow floodplains in this lower valley reach have been plowed over but they still exist fundamentally within the lower elevation of the pastures with modified channel morphometry. It appears the ditch on the east side of the valley does not function and was not used much, if at all. The ditch on the west side of the valley carries most of the water of the Antelope Creek watershed. Portions of this primary ditch were made part of, and interacted with, an unnamed tributary stream channel. The amount of water carried by the ditch during the wet season is greater than its design capacity and, given its constructed design and the erodible nature of the soil material in which it is located; it is unable to function as a stable stream channel. It is degrading in some sections, aggrading in others and widening throughout. Just upstream of Highway 49, water from the ditch is diverted back across the valley to the east and returned to the natural channels before leaving the Balderston Ranch. The location and degradation of this ditch system acts to shunt water around the natural groundwater aquifer of Antelope Valley Creek and to decrease the time water flows through the system, thereby increasing its erosive power and decreasing the amount of water available for groundwater storage.

<u>Conclusion</u>. The natural condition of the Antelope Valley watershed, its vegetation, soils, rock, topography, and drainage system slowed the downslope and downvalley movement of rainwater and snowmelt, maximizing water infiltration and groundwater retention. Large floods were infrequent and when they did occur, damage was probably light to moderate. Summer thunderstorms were localized and erosion from these intense rainstorms was most probably light to moderate. Wildfires were frequent but mostly light. Intense wildfires were very infrequent.

The impacts of human occupation and resource extraction on the watershed counteract the natural tendency of the watershed to slow and absorb water and sediment runoff. Water and sediment now moves through the watershed faster as a result of stream channel degradation and the interception of surface and ground water by the roads and the entrenchments. This faster flow of water is now more concentrated, increasing erosion and sediment transport potentials and increasing peak streamflows (increased frequency of floods). Because many of the stream channels are now located in the bottom of trenches, they are no longer connected to their floodplains. This further exacerbates the concentration of streamflows and the frequency of flooding.

Given the depth of the soils, the fractured rock formations, and the depth of the accumulated soil and rock material, the majority of the water falling on the watershed and not evaporated should be absorbed into the groundwater system. By reducing the amount of time water stays in the watershed, less is absorbed and stored to be released later. Groundwater is the source of most of the water that flows in streams and found in ponds and wetlands. The reduced storage of groundwater translates into reduced streamflows and the amount of other surface water bodies. This is especially noticeable during the summer months because the time when the streams dry is most likely earlier in the year than historically. The height of the groundwater table in relation to the rooting depth of plants is dropping sooner in the year, leading to less water available for non-irrigated plant growth (conversation with Attilio and Jim Ginasi, 2007).

Restoration Potential

The goal for treating the Antelope Valley Watershed is to restore it to proper functioning condition by reducing soil erosion and sediment transport, increasing sediment deposition and storage on naturally occurring depositional features (alluvial fans and meadow/floodplains), reducing flood-flow peaks (increased flood-flow lag times), increasing groundwater retention (raised water tables), and increasing dry-season streamflows (both amount and time).

Although the Antelope Valley Watershed is severely degraded, field reconnaissance surveys indicate that current conditions can be greatly improved through watershed restoration efforts. Much of the detrimental effects from past activities can be reversed or reduced. The objectives for watershed restoration are to:

- Reconnect streams to their remnant channels and historic floodplains.
- Raise groundwater elevations to their historic elevations.
- Reconnect diverted streams to their historic channels.
- Reconstruct roads to minimize their interference with natural runoff patterns.

The most degraded feature is the main Antelope Valley Creek channel. It now resides at the bottom of a ten-foot deep trench that continues to deepen and widen (Appendix B: Photo 4). It has little to no access to its natural floodplain and it continually drains the watershed-long groundwater aquifer. The proposed actions are to obliterate the existing entrenchment and return streamflows to the historic system of remnant stream channels and meadow floodplains. A conceptual-level restoration plan has been developed to obliterate the main Antelope Creek entrenchment from the top of the valley downstream to Palen Reservoir (Appendix B: Maps; Appendix D: Antelope Valley Meadow Restoration Proposal and Cost Estimates). Natural floodplain functions would be restored, including 1) lower flood peaks and frequency (Appendix F: Flood Frequency Analysis), 2) greater groundwater retention and higher groundwater table, 3) vigorous plant growth and expansion of the riparian area, and 4) little to no erosion of the stream system and little to no delivery of sediment downstream.

There are many intermittent and ephemeral tributaries to the main Antelope Valley Creek channel that have either downcut in response to the main channel elevation drop and/or have been diverted from their natural channels due to road or skid trail development (Appendix B: Photo 5). Where streams have been diverted from their natural channels, a second channel has eroded into place. In most cases, the diverted flow of water is concentrated, increasing erosion, speeding the draining of water from the watershed and drying out areas that would otherwise contain riparian vegetation.

A series of ditches were constructed as part of the original timber milling operation to divert water from the upper end of the valley to facilitate mill operations and for irrigation. The constructed ditch system(s) basically had the same effect as the streams diverted by roads and skid trials. The proposed restoration work would reconnect diverted streams with their natural channels. This action includes closing off existing, unnatural channels created by roads and trails. The result would delay water runoff, allowing it to soak into the ground instead of immediately running off. It would also reduce or eliminate existing soil erosion and re-water dried out meadow and riparian areas.

The current road system has changed the hydrology of the watershed by reducing the time it takes water to drain to the main stream system and out of the watershed. Streamflows are concentrated, increasing erosion and sedimentation potentials and drying out areas below the roads. The proposed restoration actions for the road system would be to reroute and/or re-drain the road system to maintain a more natural drainage pattern (Appendix A: Maps). Specific projects to restore water and sediment flow conditions imposed by roads have only partially been accomplished and needs further surveys. The Antelope Valley Road within the Meadow project reach needs to be addressed as either a complete relocation around the project reach, 1.3 miles, or a complete reconstruction within the project reach with approximately 2000 feet relocated up onto the adjacent slope to move it out of the historic floodplain (Appendix D: Antelope Valley Meadow Restoration Proposal and Cost Estimate).

The lower watershed reach has been severely impacted by the construction of Palen Reservoir and water diversion system. The ditches were constructed to redistribute water from the reservoir and to divert water around the reservoir. The reservoir was constructed using dozers to move soil material from the upstream meadow area to the dam site. The floodplain has been almost completely eliminated in the excavated area and a 10-foot drop was created in the valley that lowered the base level for the entire valley upstream and resulted in renewed headcutting and gully development upstream (Appendix B: Photo 6). Restoration of the watershed does not include removal of the Palen Dam and Reservoir. A functioning wetland has developed that includes open water and near shore, shallow wetland and riparian habitats.

The water-works that diverts water around Palen Reservoir consists of a diversion structure (Appendix B: Photo 7) located approximately 2500 feet upstream of the reservoir and a ditch from the diversion works to the main Antelope Valley Creek ditch approximately 900 feet downstream of Palen Reservoir outlet. Palen Reservoir and dam is an obstruction to natural streamflows and the upstream diversion works and spillway structure has not functioned as designed for many years. Even though water is no longer diverted into the ditch, it intercepts a significant amount of water from the adjacent hill slope causing continued erosion of the ditch as it drains back to the main channel (Appendix B: Photos 8 & 9). The proposed restoration action would remove the small diversion structure and ditch and restore natural stream and hill slope processes.

Unnamed Tributary to Bear Valley Creek

Background and General Condition

The history of this tributary watershed of Bear Valley Creek (Appendix A: Maps) includes logging, livestock grazing, road construction, and wildfires, including the Cottonwood Fire that burned as recently as 1994. The most obvious changes to what was a properly functioning watershed are poorly drained and located roads, especially the Antelope Valley Road, and the development of a discontinuous gully system along the main-stem stream channel.

Roads in this nearly 4 square mile watershed capture water flowing in small stream channels and from springs and seeps, directing and concentrating water in roadside ditches, releasing the water down slope where the roadside ditch encounters another stream channel. This overburdens that stream and causes it to adjust by accelerating the erosion and sedimentation process. Some road segments are so poorly located that they cannot drain or drain slowly, creating road segments that are easily damaged by traffic during wet conditions. Other road segments drain directly into the adjacent main stem stream channel, dumping an extra load of water and sediment.

A discontinuous gully system (one that begins and ends several times along the course of the channel) has developed along the main stem of this unnamed Bear Valley tributary stream, primarily along the upper and middle reaches. The discontinuous gully development is an indication that the system is out of balance and struggling to adjust to the hydrologic and riparian changes that have been imposed on it.

It appears that the nearly complete burn that occurred as a result of the Cottonwood Fire has caused an increase in streamflows and a loss of channel stability. The primary stabilizing component of this stream system is vegetation, both from the roots and stems of live plants and from dead plant pieces forming jams within the channel. The stream is now attempting to downcut, but there's much more sediment in the system to be transported than there is streamflow (stream power) to move it. Log jams have formed within the channel system as burned trees have decayed and fallen to the ground and into the stream. The jams that have formed within the channel are slowing the channel degradation process, contributing to its discontinuous nature and eventually to the stability of the channel.

In addition to the effects of the roads and burn, water was diverted at several locations, especially along the lower reach where the stream merges with the Bear Valley Creek system. These diversions were apparently for irrigation and as a result of road location and construction.

Restoration Potential

Because the Antelope Valley Road intercepts most of the surface water flowing to it and carries that flow in roadside ditches and on the road surface itself, water flows are concentrated, erosion and sedimentation problems are increased, and down slope areas are dewatered. The restoration action proposes to reconnect all natural drainage channels, eliminate roadside ditches and out-slope road surfaces. Specific projects have not been identified and needs further surveying to develop.

The main stream channel contains several degrading sections and several sections where the stream has been diverted. The restoration action proposes to obliterate the severely degraded stream sections and remove the stream diversions, reconnecting these stream sections to their natural channels and floodplains. Like the roads, specific projects are yet to be identified and developed. The primary exception is downstream of the stream crossing immediately adjacent to Bear Valley Meadow. This section of the stream channel is included in the Bear Valley Meadow restoration proposal, below.

Bear Valley Creek Meadow

The Bear Valley Creek Meadow (Appendix A: Maps; Appendix G: Bear Valley Meadow Surveys) is severely degraded, forming a system of actively eroding entrenchments (aka, gullies) that measure 2 to 15-feet deep and 10 to 100-feet wide (Appendix B: Photo 10). The stream system is now confined to the entrenchments and generally cannot overbank onto the historic floodplain. Groundwater drains rapidly, leaving little to augment summer streamflows and causing a dramatic change in the composition and diversity of the meadow vegetation. The degradation of the system extends the entire length of the meadow and into the upstream canyon reach, where it connects with the rapid runoff and high sediment load of that reach.

Additionally, there is a third entrenched stream system that involves shorter sections of the meadow. The ability for streamflows to frequently access floodplain areas has been almost completely eliminated as the stream channel continues to degrade into the deep alluvial soils of the meadow/floodplain complex. Because the entrenched stream system concentrates runoff and continues to actively erode its bottom and banks, it contributes significantly to the increased frequency of flooding and the high sediment loads of Smithneck Creek, directly affecting stream channel stability upstream and through the town of Loyalton.

Although it is a complicated system, the meadow can be restored to properly functioning condition. The action proposed is to obliterate the entire system of entrenchments and to re-establish streamflows to the system of channels and floodplains located on the surface of the meadow. These channels are remnants of the historic stream system prior to the degraded system we see today.

The goals of the project are to improve aquatic and riparian habitats (improve quality and increase amount), to improve conditions of water flow (reduce flood peaks and increase late season flows downstream of the project reach), and to improve water quality (reduce sediment loads, nutrient loads and summer water temperature). Project objectives are to restore the historic streamflow, floodplain, and sediment-trapping functions of the meadow, and to restore the functional attributes of the historic, unconfined aquifer by obliterating the entrenchments and by spreading streamflows onto the meadow.

A draft design has been developed that treats approximately 8000-feet (1.5 miles) of valley length by obliterating the system of entrenchments with approximately 66 soil plugs that would return the groundwater surface (water-table) to near, or at, the meadow surface (Appendix A: Maps; Appendix E: Bear Valley Meadow Restoration Proposal and Cost Estimates). This groundwater surface would be exposed in a series of ponds between the soil plugs. Ponds would form where entrenchment/meadow areas are excavated to supply soil for the construction of the plugs. The functions of the floodplains would be restored, including reducing the effects of floods (Appendix F: Flood Frequency Analysis), improving groundwater retention and raising the groundwater table and providing for vigorous plant growth, thereby expanding the riparian area, and eliminating the ongoing erosion of the main channel.

A large, well vegetated soil and rock grade-control/channel-drop structure (Appendix C: Diagrams and Charts) would be constructed at the downstream end of the project, immediately upstream of the Sierra Brooks Drive stream crossing (Appendix B: Photo 11), to support the entire project at its historic meadow elevation and to drop streamflows approximately 10-feet (total elevation difference) to the bottom of the gully before it flows through the crossing culvert. The structure would be about 300-feet long. The culvert and its boulder grade-control (located at the culvert outlet) would support the toe of the grade-drop structure.

Badenaugh Creek Area

One small meadow area on the lower end of the Badenaugh Road just above the Smithneck Creek Road (Appendix A: Maps) has been degraded by the diversion of streamflows to a small swale unable to handle the additional water. The diverted stream is primarily fed by springs located on the adjacent hillside. The diversion is caused by an old railroad grade located at the top of the meadow. The area has been further degraded by a road that is located within the stream-riparian zone and that crosses it. The road is severely rutted, channeling and concentrating water into the meadow, causing gullies to form. The restoration action proposes to reconnect the natural system of channels by obliterating the railroad grade, relocating the road out of the meadow and onto the hill slope to the south, and revegetating the obliterated areas.

Impact Avoidance and Minimization Measures

Although all of the restoration actions are proposed with the goal of improving the long-term ecological conditions of the watersheds, construction activities necessary to these restoration actions may have a potential of causing short-term impacts to natural resources such as water quality and wildlife habitat. Therefore, impact avoidance and minimization measures described in Appendix H will be implemented as part of the proposed restoration actions described above.

Discussion of Gully Obliteration Using the "Plug-and-Pond" Restoration Technique:

Gully obliteration is the only known method for restoring all the hydrologic and geomorphic functions of a meadow. Streamflows are restored to their historically unconfined position on the meadow surface where flow depths, velocities, shear stresses and stream power are low. The surface of the meadow becomes highly resistant to erosion due to vigorous plant growth watered by a shallow groundwater table. The restored stream no longer transports high sediment loads because upstream loads are captured at the top of the meadow and the actively eroding gully has been eliminated. Gully obliteration using the "plug-and-pond" technique has been found to be much less expensive than applying other treatments. Treatments such as check-dams have been estimated to cost more than ten times what it costs to obliterate gullies as here described. The use of check dams has been found to not restore meadows and their maintenance is usually very long-term.

It is more difficult and costly to implement restoration treatments in the confinement of a gully. Treatments used to stabilize a gully do not significantly reduce stream power, but rather redirects it. More rock placement and immediate revegetation work is required, increasing costs significantly. The degraded system is not restored but rather temporarily stabilized in its existing state. This stability is usually tentative because the treatments are subject to high streamflow forces, are at high risk of damage and, therefore, long-term maintenance. Erosion and sediment from the eroding entrenchment is significantly reduced, but flood frequencies and summer low flows leaving the project reach are not altered. Sediment from upstream sources can be captured within the gully, but this is usually insignificant as compared to the amount eroding from the gully itself.

To not treat a degraded meadow is to allow it to continue to degrade and widen. It will continue to do so until most or all of the meadow is removed to the elevation of the newly forming stream channel. A new stream channel and floodplain system is established at the lowered elevation. Groundwater is not captured and stored along this reach. Flood flows are again attenuated, but summer low flows are not enhanced by the captured groundwater. Sediment from upstream sources continues to influence the stability of the stream channel, but deposition in the upstream sections and, possibly throughout the untreated reach begins to raise the meadow. It has been estimated that it could take 500^+ years for the stream and its floodplain to reach this state and several thousand more years to refill the meadow to where it was prior to the latest episode of degradation.

Gully obliteration (Appendix C: Diagram 2) is the primary restoration technique recommended where the stream has degraded into a meadow formed by accumulated alluvial soils and no constraints such as houses are present. Because it is usually not economical or practical to completely fill the gully with soil, a series of soil plugs are instead constructed that are strategically placed and filled to the level of the adjoining meadow surfaces or slightly higher (Appendix B: Photo 12). Because the cost of importing soil usually renders the project very expensive or uneconomical, fill material is obtained on site by excavating the sides and bottom of the gully between the plugs. The excavated sections become filled with water as the groundwater in the meadow rises.

While an excavator is used to excavate the soil material, plug construction, including compaction, is accomplished using a rubber-tired loader. Topsoil is removed and set aside before pond excavation and then placed on the plugs to aid the revegetation effort. Wetland plant species are used to vegetate the plugs because the elevation of the finished plugs is generally at or slightly higher than the surrounding meadow. The plugs and ponds become part of the meadow floodplain and are able to absorb and spread water flows. The ponds rise and fall with the movement of floodwater through the restored meadow, reducing stream power, recharging groundwater, and reducing flood peaks (Appendix B: Photo 13).

The four primary benefits to this type of restoration are:

1. A raised groundwater table and vigorous plant growth (Appendix C: Chart 1).
2. A wide floodplain with frequent overbank flows that reduce flood peaks (Appendix C: Chart 2) and recharge groundwater.
3. Increased summer flows, especially downstream of the project (Appendix C: Chart 3).
4. Improved water quality and wetland habitats.

Restoring these processes and components re-invigorates the entire meadow ecosystem and adjacent upland areas. The effects can be realized throughout the watershed, on-sight, upstream and downstream.

Summary of Watershed improvement Projects

<u>Antelope Valley Watershed</u>

1. Obliterate the main gully and reinstall the stream to the meadow surface.
2. Reconnect natural drainage channels that have been diverted or relocated by past activities and by roads. Obliterate road and skid trail water flow interceptions, water diversion ditches, and the gullies that have formed.
3. Obliterate the Palen Reservoir bypass diversion dam and ditch.

<u>Unnamed Tributary to Bear Valley Creek</u>

1. Reconstruct the Antelope Valley Road to reconnect all drainage channels and outslope the road surface.
2. Reconnect diverted streamflows to their natural drainage channels and obliterate the diversion channels.
3. Include the lower portion of the stream and meadow system in the larger Bear Valley Meadow restoration project.

Bear Valley Creek Meadow

1. Obliterate the gully system and return the streamflows to the meadow surface, restoring groundwater conditions.

Badenaugh Road Area

1. Remove the railroad grade and return water flows to the natural channel.
2. Relocate the road out of meadow (obliterating the existing road) and repair the degraded stream channels.